

Summary of Initial Test Results for Transport Properties of Run-of-Mine Salt Backfill

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Department of Energy Office of Nuclear Energy

Used Fuel Disposition Campaign Salt R&D (1.02.08.18)

FCRD-UFD-2014-000619

SAND2014-XXXX



Sandia National Laboratories



U.S. DEPARTMENT OF
ENERGY

Introduction

This progress report represents the FY2014 progress for the 2-phase (brine and water vapor) flow-testing of intact and reconsolidated salt samples. This work is funded by US Department of Energy Office of Nuclear Energy (DOE-NE) Used Fuel Disposition (UFD) campaign as a level-4 milestone in work package FT-14SN081805 ("Salt R&D to support Field Studies - SNL") and is controlled through Test Plan SNL-FCT-TP-14-002, *"Experimental Investigation of Two-Phase Flow in Rock Salt"*. As the Department of Energy is fully aware, this work has been greatly impacted by the lack of access to the Waste Isolation Pilot Plant (WIPP) underground in Carlsbad, NM. Without access to the WIPP underground Sandia National Laboratories cannot access our core library (our existing inventory of intact salt samples) or obtain additional run-of-mine (i.e., crushed) salt for testing. Until access to the WIPP underground is re-established, the work has focused on testing samples of reconsolidated crushed salt, using existing samples.

Laboratory Testing

An initial set of scoping tests were identified through several technical exchanges with Core Laboratories in Houston, TX. The scope of the testing developed with Core Laboratories will include up to 5 samples and the following test methods (discussed in Test Plan SNL-FCT-TP-14-002):

- 1) All specimens will be tested to determine a Low Gas Permeability using a pulse decay method. This method is non-invasive and should not damage the samples. Using this method we should develop a basic understanding of the sample gas permeability.
- 2) Initially the plan was to then perform High Speed Centrifuge Capillary Pressure testing on a minimum of two specimens. With an epoxy shell, this testing will be deferred until we get clean reconsolidated salt specimens.

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- 3) The specimens tested using the High Speed Centrifuge were then going to be tested using Mercury Injection to determine the capillary pressure. This will also be delayed until clean reconsolidated salt specimens are available.
- 4) A Stationary Relative Permeability-to-Gas test will be performed on one of the samples tested in item #1.
- 5) A Low Liquid Permeability – Pulse-Decay testing will be performed on one of the samples tested in item #1.
- 6) A Threshold (Entry Gas) Pressure test at ambient temperature will be performed on one of the samples tested in item #1.

The contract with Core Laboratories includes the scope to perform all of the testing identified above. As we have had to build up cylindrical samples using epoxy and rectangular reconsolidated salt samples, the capillary pressure tests will be delayed until we can create full cylindrical reconsolidated crushed salt specimens. This will require access to additional crushed salt from the WIPP underground. Presently only three samples have been sent to Core Laboratories, and only items 1, 4, 5, and 6 will be performed with the three samples discussed later in this document.

All of the initial testing at Core Laboratories is considered scoping in nature and is primarily focused on assessing their capabilities to measure low permeability salt samples to determine the preferred methods for performing two-phase flow measurements. Depending on the success of the various tests a full suite of tests with both reconsolidated and intact salt samples would be performed as discussed in Test Plan Test Plan SNL-FCT-TP-14-002.

Sample Preparation

Access to the WIPP underground has been shut down since the February 9, 2014 truck fire in the underground. Without underground access, we are unable to collect existing cored samples of salt or the mined crushed salt that will be needed to create new reconsolidated salt samples for use in testing as part of the initial 2-phase flow testing activity. As a work around, three separate specimens have been created from existing 4 inch diameter by approximately 5 inch length specimens that were reconsolidated in support of the work documented in SAND2014-2240 (Bauer 2014). The 4 inch diameter samples were sliced axially in half as part of this prior testing program leaving us $\frac{1}{2}$ of 4" diameter sample for creating new specimens. For the two-phase flow work these halves were then cut into rectangular "pipes" using a wire saw. The wire saw provides a very low impact, low vibration and non-invasive method for cutting the samples. Initial attempts were made to sub-core these cylinders of reconsolidated salt using a drill and core barrel, but the vibration associated with this method caused the specimen to break apart.

The planned testing at Core Laboratories requires a cylindrical specimen. To create this shape the cut rectangular specimens were potted in two types of epoxy using a 1.5 inch diameter PVC pipe as the form. A thin slip coat of Devcon "5 minute epoxy" was initially applied to the surface area of specimens to set the surface area and prevent the epoxy from flowing into the pore space. The primary fill epoxy

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was a Dural 335 Ultra Low viscosity product. As can be seen in the photos attached to the end of this letter, we created a larger cylindrical specimen out of the rectangular reconsolidated crushed salt pipes. The surface area dimensions for the original parallel pipes are listed in Table 1. With the epoxy the final cylinders are nominally 1.5 inch in diameter with lengths that range between 4.20 to 4.75 inches for the three samples.

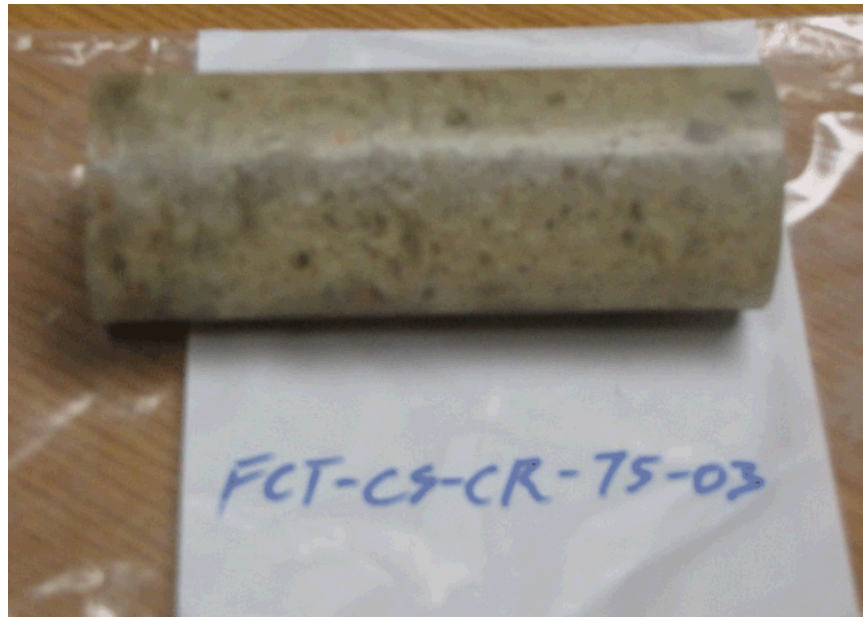
Table 1. Length of Sides of Parallel Pipes Cut From Larger Specimens

Specimen ID	Side A (inches)	Tolerance (+/- inches)	Side B (inches)	Tolerance (+/- inches)
FCT-CS-CR-75-03	1.135	0.005	1.138	0.017
FCT-CS-CR-100-03	1.156	0.001	1.132	0.005
FCT-CS-CR-250-01	1.012	0.001	1.105	0.003

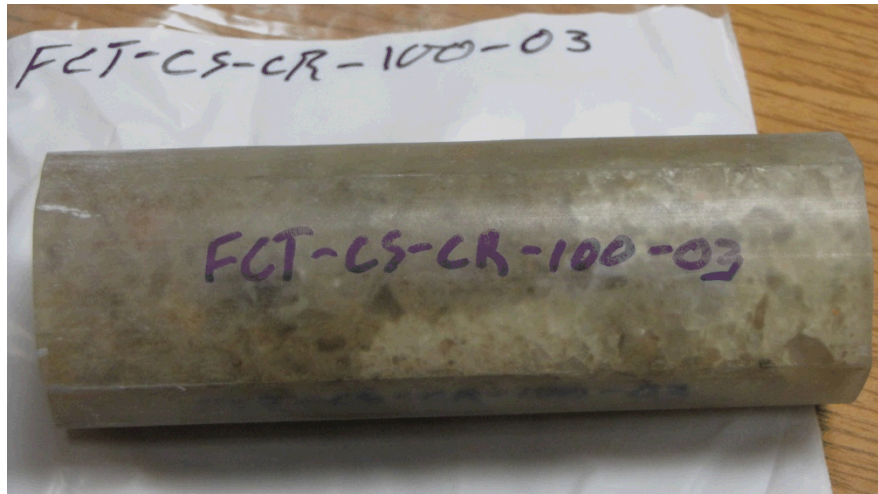
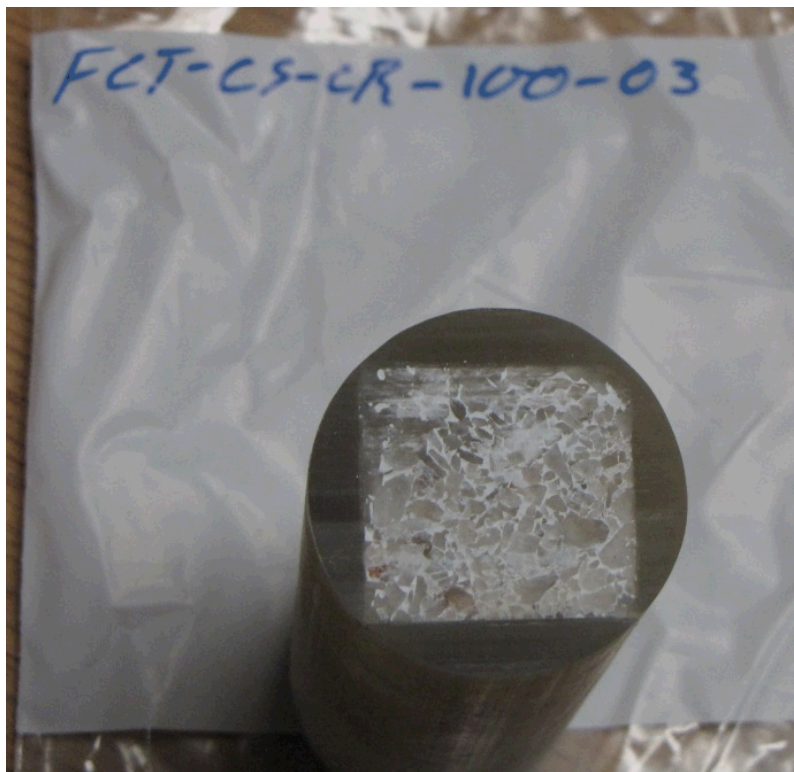
Completion of work in FY15

The present plan is to complete the testing with Core Labs with the completed cores shown in the photos, and prepare additional samples (both reconsolidated crushed salt and damaged intact salt) to be tested in a similar manner at Core Labs. Once this scoping testing contract is complete, the results will be reported in a level-4 milestone report in FY15. This work will be paid for with a combination of UFD carryover funds left from FY14 and a small amount of additional UFD funding in FY15.

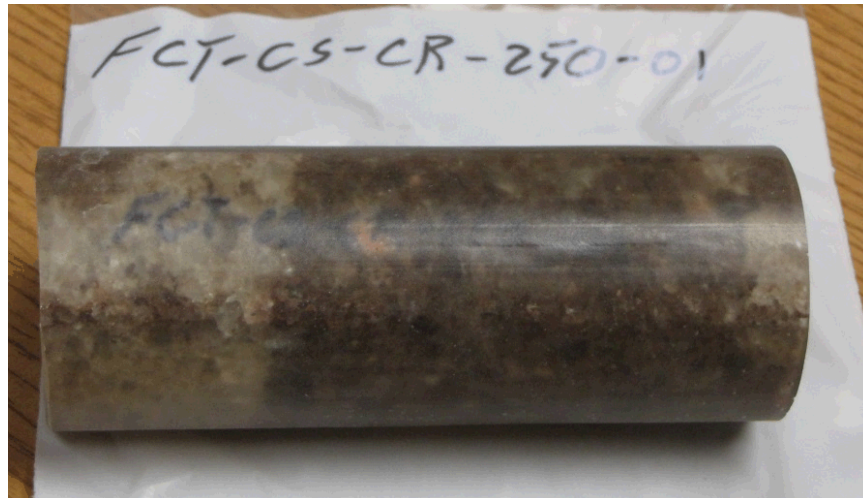
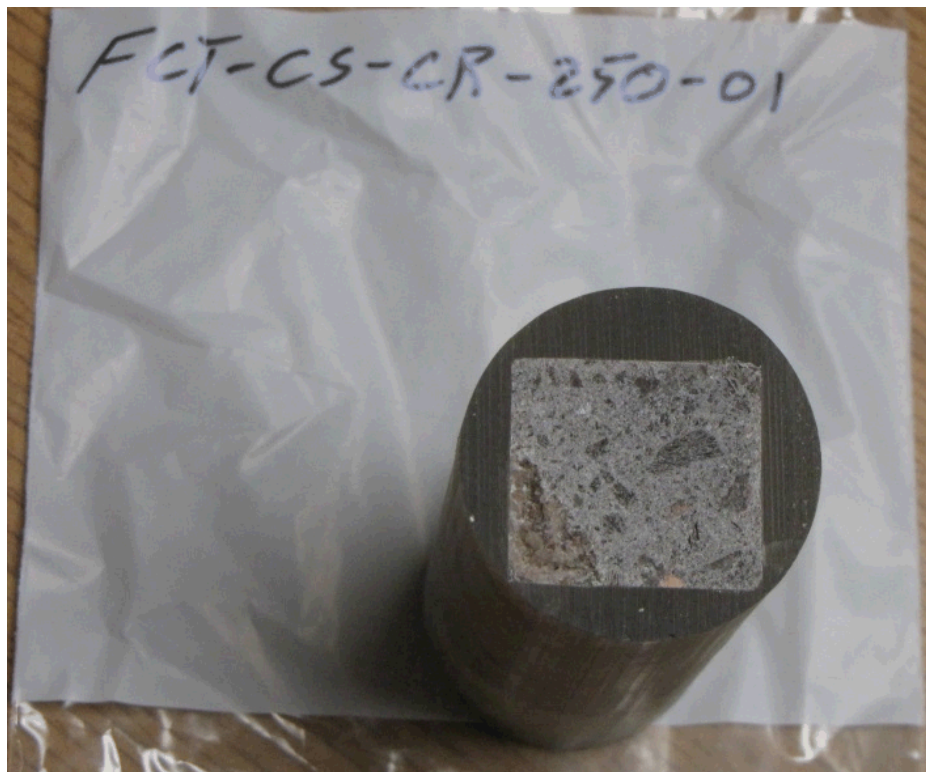
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APPENDIX E

FCT DOCUMENT COVER SHEET ¹

Name/Title of Deliverable/Milestone/Revision No. Summary of Initial Test Results for Transport Properties of Run-of-Mine Salt Backfill / M4FT-14SN0818051 / Rev 0

Work Package Title and Number Salt R&D to Support Field Studies – SNL (FT-14SN081805)

Work Package WBS Number 1.02.08.18

Responsible Work Package Manager Kris Kuhlman 
(Name/Signature)

Date Submitted

Quality Rigor Level for Deliverable/Milestone ²	<input checked="" type="checkbox"/> QRL-3	<input type="checkbox"/> QRL-2	<input type="checkbox"/> QRL-1 Nuclear Data	<input type="checkbox"/> Lab/Participant QA Program (no additional FCT QA requirements)
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This deliverable was prepared in accordance with Sandia National Laboratories
(Participant/National Laboratory Name)

QA program which meets the requirements of
☒ DOE Order 414.1 ☐ NQA-1-2000 ☐ Other

This Deliverable was subjected to:

☒ Technical Review

Technical Review (TR)

Review Documentation Provided

- ☐ Signed TR Report or,
☐ Signed TR Concurrence Sheet or,
☒ Signature of TR Reviewer(s) below

Name and Signature of Reviewers

Dale Bowman

☐ Peer Review

Peer Review (PR)

Review Documentation Provided

- ☐ Signed PR Report or,
☐ Signed PR Concurrence Sheet or,
☐ Signature of PR Reviewer(s) below



NOTE 1: Appendix E should be filled out and submitted with the deliverable. Or, if the PICS:NE system permits, completely enter all applicable information in the PICS:NE Deliverable Form. The requirement is to ensure that all applicable information is entered either in the PICS:NE system or by using the FCT Document Cover Sheet.

NOTE 2: In some cases there may be a milestone where an item is being fabricated, maintenance is being performed on a facility, or a document is being issued through a formal document control process where it specifically calls out a formal review of the document. In these cases, documentation (e.g., inspection report, maintenance request, work planning package documentation or the documented review of the issued document through the document control process) of the completion of the activity, along with the Document Cover Sheet, is sufficient to demonstrate achieving the milestone. If QRL 1, 2, or 3 is not assigned, then the Lab / Participant QA Program (no additional FCT QA requirements) box must be checked, and the work is understood to be performed and any deliverable developed in conformance with the respective National Laboratory / Participant, DOE or NNSA-approved QA Program.